PUB 42501

PRELIMINARY

Bell System Voice Communications
TECHNICAL REFERENCE

Voice Connecting Arrangement CDQ4W

Interface Specification

August 1969

ENGINEERING DIRECTOR - CUSTOMER TELEPHONE SYSTEMS

NOTICE

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If further information is required, please contact:

Engineering Director - Customer Telephone Systems
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

PREFACE

The material in this Technical Reference is intended for use by designers and manufacturers of telephone equipment who expect to connect their communications equipment to the Bell System telecommunications network. This material covers guides which, if followed, should permit the transmission and reception of voice signals without interference to other Telephone Company services.

The responsibility of the Bell System with respect to the use of customer-provided equipment is as set forth in the appropriate Tariff regulations.

In furnishing this material, the Bell System Telephone Companies make no claims or representations and assume no responsibility, beyond that set forth in the Tariff regulations, for the suitability of the transmission path or the performance of the telecommunications system. The Bell System is in no way responsible for the design, performance, installation, operation or maintenance of the communications systems or equipment provided by others which are connected to the telecommunications network and does not endorse or approve any such system or equipment. The material in this Technical Reference is furnished in the interest of preventing interference to other Telephone Company services and users, and is not furnished with the intent to provide complete design specifications or parameters, or to assure the quality or performance of customer-provided telephone systems and equipment.

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1. GENERAL

F.C.C. Tariff No. 260 and corresponding intrastate Tariffs filed by the Bell System provide for the direct connection of customer-provided voice transmitting and receiving terminal equipment and communications systems to Bell System telecommunications network. Direct electrical connection is made through a voice connecting arrangement furnished, installed, and maintained by the Telephone Company. The Tariffs also provide for the indirect (acoustic or inductive) connection of such equipment or systems.

In addition, the Bell System retains responsibility for network control signaling. This includes the switchhook, dialing and control functions, as well as the protective function of voice signal limiting and isolation of Telephone Company battery from the customer-provided equipment.

For new or additional service, contact your local Telephone Company business office or Marketing representative. For ready identification, the Telephone Company describes this service as Voice Connecting Arrangement CDQ4W.

2. SYSTEM DESIGN CONSIDERATIONS

2.1 Voice Connecting Arrangement CDQ4W

Voice Connecting Arrangement CDQ4W provides a 4-wire connection between two customer-provided communications systems, or between a customer-provided communications system and a Bell System-provided communications system. This arrangement, located in close proximity to the customer-

provided equipment, provides for signaling, answer supervision, and voice frequency coupling. For transmission purposes, two pair of TRANSMISSION leads (receive pair and transmit pair) provide the voice transmission paths between this arrangement and the customer-provided communications system. Two pair of SUPERVISORY leads provide the means to supply answer supervision for incoming calls and to initiate outgoing calls. The distant PBX must be terminated in equipment compatible to this arrangement.

2.2 Service and Maintenance Considerations

2.21 Responsibility of the Customer

The Tariffs permitting direct electrical connection of customer-provided communications systems state that:

> Where private line service is available under this Tariff for use in connection with customer-provided terminal equipment or communications systems, the operating characteristics of such equipment or systems shall be such as not to interfere with any of the services offered by the Telephone Company. Such use is subject to the further provisions that the customer-provided equipment or systems does not endanger the safety of Telephone Company employees or the public, damage, require change in or alteration of, the equipment or other facilities of the Telephone Company; interfere with the proper functioning of such equipment or facilities; impair the operation of the Telephone Company's facilities or otherwise injure the public in its use of the Telephone Company's services. Upon notice from the Telephone Company that the customer-provided equipment or systems is causing

or is likely to cause such hazard or interference, the customer shall make such change as shall be necessary to remove or prevent such hazard or interference.

2.22 Responsibility of the Telephone Company

The Tariffs permitting direct electrical connection of customer-provided communications systems state that:

> The Telephone Company shall not be responsible for installation, operation or maintenance of any customer-provided terminal equipment or communications systems. Private line service is not represented as adapted to the use of customer-provided equipment or systems and where such equipment or systems is connected to Telephone Company facilities the responsibility of the Telephone shall be limited to the furnishing of facilities suitable for private line service and to the maintenance and operation of such facilities in a manner proper for such private line service; subject to this responsibility the Telephone Company shall not be responsible for (i) the through transmission of signals generated by the customer-provided equipment or systems, or for the quality of, or defects in, such transmission, or (ii) the reception of signals by customer-provided equipment or systems.
>
> The Telephone Company shall not be responsible to the customer or otherwise if changes in the criteria contained in the Tariffs and Paragraph 5 of this Technical Reference, or in any of the facilities, operations, or procedures of the Telephone Company

render any customer-provided facilities obsolete or require modification or alteration of such equipment or system or otherwise affect its use or performance.

2.23 Trouble Reporting Procedure

When trouble is experienced with this service, the customer should perform the necessary testing to sectionalize the difficulty by opening the circuit at the Interface Connecting Block and testing only toward the customer-provided equipment. If the tests indicate the trouble is in the Telephone Company-provided equipment, it should be promptly reported to the Telephone Company. Trouble reports should be called to the listed "Repair Service" number which can be found in the front of the telephone directory. The repair attendant should be given:

(a) Customer's name.

(b) Customer's address.

(c) Listed telephone number.

(d) Description of the trouble.

(e) Customer's contact for additional information.

2.3 Foreign and Surge Voltage Protection

Where telephone lines are exposed to lightning, power circuit contact, or induction, protective devices are installed at the Central Office and on the customer's premises that will provide a path to ground for foreign voltages that exceed about 600 volts peak. Since the customer's equipment is connected to the telephone line through

the voice connecting arrangement, the customer's equipment is protected from longitudinal surges by transformer isolation. It is not expected that the customer's equipment will be subjected to excessive foreign potential from the voice connecting arrangement.

The customer is responsible for providing protection, internal to his equipment and facilities, against surge and hazardous voltages from his equipment and facilities being applied to the voice connecting arrangement.

2.4 Hazardous Voltage Limitations

When it is necessary for the customer to apply an operational voltage to facilities interconnected with telephone facilities, certain voltage limitations shall be observed. These limitations are for the purpose of providing adequate protection to personnel and plant facilities, and unless otherwise specified in Paragraph 4.2 and 4.3 of this Technical Reference, steady-state voltages applied by customer-provided equipment to conductors connected to Voice Connecting Arrangement CDQ4W should not exceed the following:

	dc	ac (RMS)
Maximum voltage, any conductor to ground	135	50
Maximum voltage, conductor to conductor	(135 (270*	(50 (100*

*Permitted only if voltage source is center-tapped to ground.

The power supplies and wiring methods used in the customer-provided equipment should meet the provisions of the National Electrical Code (NEC), Article 725, for Class 2 remote control and signal circuits.

3. DESCRIPTION OF VOICE CONNECTING ARRANGEMENT CDQ4W

3.1 Physical

Voice Connecting Arrangement CDQ4W is arranged to be assembled on a standard 23 inch relay rack (Fig. 1). The relay rack will be mounted by the Telephone Company in an appropriate location so that the front and back of this arrangement are accessible for testing and maintenance. Essentially, Voice Connecting Arrangement CDQ4W consists of a voice repeater circuit (4-wire voice transmission), a signaling circuit (to receive and transmit signals over the 4-wire loop), and an applique circuit (for dc isolation of customer seizure, dialing and answer supervision). Each equipment group, i.e., 2 repeater shelves, a signaling panel, and an applique panel, provides facilities for four tie trunks. A -48 volt power supply (12 trunk circuit capacity) is also mounted on the relay rack. The customer must provide a separate fused (15A), 105-130 volt, 60 Hz ac outlet for each -48 volt power supply not under control of a switch and within reach of the power cord. This arrangement will function satisfactorily within a temperature range of 0° to 55°C and a humidity range from 5 to 95 percent. Leads from this arrangement are terminated on a Telephone Company-provided Interface Connecting Block (Fig. 2) conveniently located to permit testing, maintenance, trouble isolation, and ease of connection to the customer's equipment.

3.2 Functions

The major functions of this voice connecting arrangement are:

(a) To provide voice-only access to and from the customer-

provided equipment.

(b) To provide for repeating signaling pulses from the customer-provided equipment to the distant equipment.

(c) To accept dial pulses from the distant equipment and repeat these dial pulses into the customer-provided equipment.

(d) To limit abnormally high voice signal voltages.

(e) To provide dc isolation to customer-provided equipment.

3.3 Originating and Receiving a Call

3.31 Incoming Call from the Distant PBX

When the distant PBX seizes the line connected to this arrangement, the signaling circuit detects that seizure and causes a relay in the applique circuit to operate (see Fig. 3). This relay closes a contact (over CBS1 and CBS2 leads) to which the customer-provided communications systems must respond by connecting signal receiving equipment to this contact and returning dial tone, if provided, over the transmit pair to the distant PBX. When dialing is completed and the station has answered, the customer-provided equipment must provide a contact closure, over the CS and CG leads, to operate a relay in the applique circuit. This relay, in operating, transmits answer supervision to the distant PBX. The repeater provides a 4-wire voice frequency transmission path to the customer-provided equipment (see Fig. 3).

3.32 Outgoing Call to the Distant PBX

The customer-provided dial communications system causes the voice connecting arrangement to seize the tie trunk by providing a contact closure over the CS and CG leads. This contact closure operates a

relay in the applique circuit. The closure is forwarded to the signaling circuit at the distant PBX resulting in dial tone being returned when provided. The customer-provided contact closure, on the CS and CG leads opens and closes with dial pulses from the customer's equipment. This causes the relay in the applique circuit to operate and release, thereby repeating dial pulses to the distant PBX. When answer supervision is returned from the distant end, it is detected by the signaling circuit of this arrangement which causes a relay in the applique circuit to operate. This relay closes a contact over CBS1 and CBS2 leads to repeat answer supervision to the customer-provided equipment. The repeater provides a 4-wire voice frequency transmission path to the customer-provided equipment.

3.33 Disconnection

If the distant end disconnects first, a relay in the applique circuit releases which opens the contact closure over the CBS1 and CBS2 leads to the customer-provided equipment. The customer-provided equipment must recognize this as a disconnect signal and open the contact closure over leads CS and CG. If the customer-provided equipment connected to this arrangement disconnects first, the customer-provided contact closure, over the CS and CG leads, opens and a relay in the applique circuit releases. This in turn signals the distant end. The distant end will then return a disconnect signal which is then transmitted to the customer-provided equipment as an open between leads CBS1 and CBS2.

3.4 Interface Leads

Eight interface leads (4-pair) per tie trunk are provided from the Voice Connecting Arrangement CDQ4W to an Interface Connecting Block (see Fig. 2) for the customer's use. Technical information pertaining to these leads is discussed in Paragraph 4 - ELECTRICAL CHARACTERISTICS.

The first pair, designated CT1 and CR1, provides a one-way voice transmission path from the distant PBX to the customer-provided equipment (receive pair). The second pair, designated CT and CR, provides a one-way voice transmission path from the customer-provided equipment to the distant PBX (transmit pair). The third pair, designated CS and CG, provides for seizing the tie trunk and repeating dial pulses to the distant PBX on outgoing calls and provides answer supervision to the distant PBX on incoming calls. The fourth pair, designated CBS1 and CBS2, provides for seizing and inpulsing of the customer-provided equipment on incoming calls and provides answer supervision from the distant PBX on outgoing calls.

The customer must provide and install the conductors from the customer-provided communications systems to the Interface Connecting Block. This block will accept leads of 18 gauge or smaller.

3.5 Method of Connection

The leads from Voice Connecting Arrangement CDQ4W will be terminated by the Telephone Company in a terminal box (4 tie trunks per box) equipped with the Interface Connecting Block (Fig. 2). The cus-

tomer or his representative will make the necessary connections to associate his equipment with the voice connecting arrangement at this terminal box. The leads from the voice connecting arrangement will be terminated by the Telephone Company on studs under washers secured by nuts on the Interface Connecting Block mounted in the box. Separate nuts and washers on the same studs will be provided for the customer's connections. These will be designated as follows:

Lead Designation	Function
CT1 CR1	voice transmission pair (receive)
CT CR	voice transmission pair (transmit)
CS CG	supervisory leads transmit
CBS1 CBS2	supervisory leads receive
2	designates second circuit
3	designates third circuit
4	designates fourth circuit

4. ELECTRICAL CHARACTERISTICS

4.1 General

The customer's equipment must furnish its own talk and signal battery. Voice Connecting Arrangement CDQ4W provides for voice signal amplification.

4.2 Receive and Transmit Paths

Leads designated CT1, CR1, and CT, CR.

4.21 Transmission Parameters

In order to prevent interference to other telephone service, customer-generated voice signal levels must comply with certain minimum protection criteria. F.C.C. Tariff No. 260 which provides for the electrical connection of customer-provided communications systems with facilities furnished for private line service by the Telephone Company states that:

> "Since private line channels utilize Telephone Company facilities in common with other services, it is necessary in order to prevent excessive noise and crosstalk that the power of the signal applied to the Telephone Company lines be limited. Because each private line service is individually engineered a single valued limit for all applications cannot be specified. Therefore, the power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premise will be specified by the Telephone Company for each application to be consistent with the signal power allowed on the telecommunications network."

For Voice Connecting Arrangement CDQ4W the maximum acceptable voice signal power at the Interface Connecting Block is -29 dBm on leads CT, CR (transmit pair) when averaged over any 3-second interval.

The customer-provided equipment must not supply any dc on leads CT1, CR1, and CT, CR toward the voice connecting arrangement.

4.3 Supervisory Paths

4.31 Leads Designated CS and CG

This pair of leads provides the means of answering an incoming call and initiating an outgoing call from the customer's communications system. The customer's equipment must provide a closure to answer an incoming call; continue that closure throughout the duration of the call; open these leads when the customer's equipment disconnects first at the completion of the call and maintain the open until an open appears on the other service request leads CBS1 and CBS2. In the case where the distant PBX disconnects first (indicated by an open on leads CBS1 and CBS2), the customer's equipment must open leads CS and CG within 500 milliseconds. When a call is initiated, the customer's equipment is expected to provide and maintain a closure throughout the duration of the call (except for dialing, when these leads are opened and closed in unison with dial pulses), open these leads at the completion of the call, and maintain the open until the next call.

The CS lead has a maximum of -52 volts dc through 4000 ohms. The CG lead is grounded at the voice connecting arrangement. (See 4.4, Grounding). Leads CS and CG will load the customer's contact with 0.013 ampere, maximum, inductive load. Due to the inductive nature of the load, a contact protection network is provided across leads CS and CG in the voice connecting arrangement (see Fig. 3).

4.32 Leads Designated CBS1 and CBS2

This pair of leads, provides the distant PBX with a means for seizing and inpulsing to the customer-provided equipment on incoming calls.

These leads also provide the customer's equipment with answer supervision from the distant PBX on outgoing calls. The customer's equipment must recognize an initial closure between these leads, provided by this arrangement, as an incoming call. The customer's equipment must also respond to opens and closures between these leads, which correspond to dial pulses generated by the distant PBX. The closure will then be maintained for the duration of the call.

At the completion of a call, if the distant end disconnects first, the customer's equipment must recognize an open between these leads as a disconnect signal. In this case, the customer's equipment must open the closure between leads CS and CG within 500 milliseconds.

On an outgoing call, the customer's equipment must recognize a closure between these leads as an indication that the distant PBX has answered (see Fig. 3).

The current from the customer's equipment on these leads shall not exceed 0.1 ampere.

4.33 Dial Pulse

Dial pulses generated by the customer-provided equipment, over the interface leads CS and CG to the voice connecting arrangement, must be at a rate between 8 and 11 pulses per second with a percent break of between 58 and 64 percent. A minimum of 600 milliseconds must be provided between digits (see Fig. 5). The contact used to supply dial pulse information shall be of such a nature as to provide bounce-free transitions during dialing. The customer-provided equipment must also

be able to receive dial pulses, at any rate between 8 and 11 pulses per second with a percent break of between 25 and 90 percent, generated by the voice connecting arrangement over the interface leads CBS1 and CBS2. A minimum of 600 milliseconds will be provided between digits. It is expected, when dial signaling is used, that each receiving end (i.e., both the Bell System and the customer-provided ends) will be equipped with pulse correction.

4.4 Grounding

In general, it is desirable that circuits in the customer's equipment which connect to the voice connecting arrangement have some path to ground. A direct or resistive ground on one side of the power supply would be an example of such a path. This practice avoids the possibility of the entire circuit involved being at an indeterminate potential with respect to ground. Such a potential, perhaps as a result of electrostatic induction, could result in an insulation breakdown in this arrangement. It is expected that the customer's equipment, if powered from commercial power, will be grounded in accordance with applicable electrical codes (NEC) and should be bonded to the telephone protection ground electrode when available. Self-powered or passive customer's equipment need not be grounded.

Voice Connecting Arrangement CDQ4W is provided with a common signal ground (a metallic cold water pipe or other ground approved by the NEC) which is always bonded to the electric power ground and telephone protector ground where present. The CG lead of the SERVICE REQUEST pair is grounded at the unit. If necessary, this SERVICE REQUEST ground lead may be connected

to the frame ground of the customer's equipment. However, it is not permitted to derive the main ground for the customer's equipment through this lead.

As an example, a good ground may be obtained with a proper connection to a metallic cold water pipe, using a single No. 6 AWG copper conductor. The other end should be connected to the ground return terminal of the customer's equipment. The run should be short, straight, and, if possible, a continuous piece of wire. Proper attention should be given to providing the lowest possible resistance connection at each end of the circuit. It is imperative that this ground be connected at the same location to the water piping system as the telephone protector or signal ground. This lead shall not be fused.

5. DESIGN CONSIDERATIONS FOR CUSTOMER-PROVIDED EQUIPMENT

5.1 Customer-Provided Terminal Equipment

For purposes of connecting to Voice Connecting Arrangement CDQ4W the typical customer-provided terminal equipment might consist of a trunk circuit, a 4-wire terminating set and two 600 ohm variable pads (see Fig. 4).

The functions of the customer-provided trunk circuit are:

(a) To convert customer signaling into signaling suitable for use with Telephone Company signaling over supervisory leads.

(b) To connect the 2-wire voice path, switched through the customer-provided switching machine, to the 2-wire port of the 4-wire terminating set.

(c) To provide an idle circuit termination to keep the channel stable when the circuit is in the idle state. Termination must be automatically removed by the customer's equipment when the circuit is seized from either direction.

The function of the customer-provided 4-wire terminating set is to convert the 2-wire voice path into separate 600 ohm transmit and receive directions. The transmission loss of a typical terminating set from the 2-wire port to either the transmit or receive (4-wire) ports is a nominal 4 dB.

The function of the customer-provided 600 ohm variable loss pads is to allow adjustments of the signal levels, applied to the voice connecting arrangement, and the overall circuit loss.

5.2 Transmission Level Points (TLP)

In order to specify the levels between which the tie trunks will operate, common reference levels between the Telephone Company and the customer are required. For a tie trunk, the PBX switch in the outgoing (transmit) direction, at each end, will be designated the 0 Transmission Level Point (TLP) for that direction of transmission. All other level points on the tie trunk will be referred to this point by the nominal loss (-) or gain (+) in dB between them at 1000 Hz. In designing their tie trunk facilities the Telephone Company will provide +7 (receive pair) and -16 (transmit pair) transmission level points at the Interface Connecting Block as shown in Fig. 4. These values were chosen to provide standard interface levels which are readily available in

commercial channel, signaling, and terminal equipment. Another advantage is that the customer's terminal equipment is not required to have gain devices.

5.3 Loss Adjustment

5.31 Transmit Direction

The value -16 TLP at the Interface Connecting Block requires the customer to adjust the variable pad in the transmitting direction so that the loss from the PBX switch (0 TLP) to the Interface Connecting Block (-16 TLP) is 16 dB (see Fig. 4).

5.32 Receive Direction

The desired loss in the receive direction, i.e., +7 TLP, is a function of several factors including the intended use of the trunk, its length, and the type of channel facilities provided by the Telephone Company. Suggested loss values and other transmission engineering information for tie trunks will be covered in a forthcoming Technical Reference expected to be available from:

Engineering Director - Transmission
American Telephone & Telegraph Co.
195 Broadway
New York, New York 10007

In the interim, those persons seeking further information should contact their Telephone Company Transmission Engineering representative through the local business office or Marketing representative.

5.4 Signal Levels

5.41 In-Band Limits

The customer-provided communications systems should be so designed

that the maximum total power, averaged over any 3-second interval, applied to the Interface Connecting Block associated with Voice Connecting Arrangement CDQ4W does not exceed -29 dBm on leads CT, CR (transmit pair).

The telecommunications network incorporates tone signaling devices that are used or network control functions. These devices, connected at all times to the telephone circuit, are designed to be sensitive to single frequency tones at 2600 Hz. They are, however, relatively insensitive to energy at this frequency if sufficient energy is present at the same time in other frequencies of the voice band.

In order to prevent the interruption or disconnection of a call, or interference with network control signaling, it is necessary that the signal applied by the customer-provided equipment to the voice connecting arrangement at no time have energy solely in the 2450 to 2750 Hz band. If signal power is in the 2450 to 2750 Hz band, it must not exceed the power present at the same time in the 800 to 2450 Hz band.

5.42 Out-of-Band Limits

To protect other services it is necessary that the signal which is applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises, meet the following limits measured at the leads CT and CR on the Interface Connecting Block at the -16 TLP. See Fig. 4.

INTERFACE CONNECTING BLOCK	MAXIMUM ACCEPTABLE OUT-OF-BAND SIGNAL POWER LIMITS				
	3995 to 4005 Hz	4000 to 10,000 Hz	10,000 to 25,000 Hz	25,000 to 40,000 Hz	Above 40,000 Hz
Leads CT, CR (Transmit Pair)	-47 dBm	-32 dBm	-40 dBm	-52 dBm	-66 dBm

5.5 Internal Impedance

The internal impedance of the customer's equipment should be approximately 600 ohms.

6. TESTING AND MEASURING METHODS

6.1 Measuring Maximum Available Power

The following measuring method is satisfactory for estimating the maximum power averaged over a 3-second interval to determine that the inband criterion is being met:

Operate the customer-provided equipment into a 600 ohm load (this assumes that the customer-provided equipment has a 600 ohm source impedance) bridged by a Hewlett-Packard Telephone Test Meter 3555B, or a Western Electric 3C(3A) Noise Measuring Set, or the equivalent.* The meter FUNCTION switch should be in the BRIDGE position, the slide switch marked DAMP/NORM in the DAMP position, and 3kHz flat weighting should be used. In almost all cases the speech power averaged over any 3-second interval will not exceed -29 dBm if the maximum meter swing does not exceed 64 dBrn.

The accuracy of this method can be somewhat improved by increasing the size of the damping capacitance in the Western Electric 3C or 3A Noise Meter by 150 microfarads. To do this connect the negative lead

*These meters do not have a 3-second averaging time, but when used on speech they give a reliable estimate of a 3-second average.

of a 150 microfarad capacitor to either terminal of the NORM/DAMP switch and connect the positive lead to ground. This allows the meter to more nearly approximate a 3-second averaging meter. (NOTE: This modification does not necessarily hold for noise meters other than the Western Electric 3C and 3A). With the additional damping the power averaged over any 3-second interval will not exceed -29 dBm if the maximum meter swing does not exceed 62 dBrn. The use of meters with shorter time constants, such as a VU meter or a standard voltmeter, is not recommended.

7. TELECOMMUNICATIONS NETWORK CHARACTERISTICS

7.1 Transmission Parameters

Information describing the component parts and operating characteristics of the Bell System telecommunications network has been published. These articles are listed in Paragraph 8. In addition, five general information texts are listed.

7.2 End-to-End Electrical Loss

The end-to-end electrical loss of a connection is a function of the impedances of both end terminations and the losses of the loops. The information given in the references may be used to determine statistical loss distribution.

7.3 Bandwidth and Frequency Response

The voice frequency bandwidth extends from about 300 to 3000 Hz. In general, an end-to-end connection may be expected to have a loss characteristic which increases with increasing frequency in the upper half of the band. This voice connecting arrangement does not limit this bandwidth.

7.4 Nonlinearities

Nonlinearities such as compression, clipping, and harmonic distortion can exist on the telecommunications network. Normally, these are low enough to be ignored. It is expected that total harmonic distortions no greater than about 5 percent of the fundamental will normally be encountered.

8. REFERENCES

Some references describing various transmission characteristics are listed below:

(a) Breen, C., and Dahlbom, C.A., "Signaling Systems for the Control of Telephone Switching," Bell System Technical Journal, 39, No. 6 (November 1960) p. 1381.

(b) Bodle, D.W. and Gresh, P.A., "Lightning Surges in Paired Telephone Cable Facilities," BSTJ, 40, No. 2 (March 1961), p. 547.

*(c) "Principles of Electricity Applied to Telephone and Telegraph Work," by American Telephone and Telegraph Company, New York, New York.

*(d) "Switching Systems," by American Telephone and Telegraph Company, New York, New York.

(e) "Notes on Transmission Engineering," by United States Independent Telephone Association, Washington, D.C.

*(f) "Notes on Distance Dialing - 1968," by American Telephone and Telegraph Company, New York, New York.

*(g) "Transmission Systems for Communications," by Bell Telephone Laboratories.

*Available through Graybar Electric Company.

9. GLOSSARY*

CHANNEL - denotes a path (or paths) for electrical communications between two or more stations or Telephone Company offices furnished in such a manner as the Telephone Company may elect, whether by wire, radio or a combination thereof and whether or not by means of a single physical facility or route.

COMMUNICATIONS SYSTEMS - denotes channels and other facilities which are capable, when connected to private line services, of communications between customer-provided terminal equipment or Telephone Company stations.

VOICE CONNECTING ARRANGEMENT - Voice Connecting Arrangement CDQ4W provided by the Telephone Company to accomplish the direct electrical connection of customer-provided facilities with the facilities of the Telephone Company or the direct electrical connection of Telephone Company facilities.

CUSTOMER-PROVIDED TERMINAL EQUIPMENT - devices, apparatus, and their associated wiring, provided by a customer, which do not constitute communications systems and which, when connected to the communications path of the telecommunications system, are so connected either electrically, acoustically, or inductively.

DIAL PULSE RATE - repetition of pulses for switching purposes, usually expressed in pulses-per-second.

FOUR-WIRE CIRCUIT - a two-way circuit using two paths so arranged that signals are transmitted in one direction only by one path and in the

* May differ in letter from exact wording as used in the Tariffs

other direction only by the other path. The transmission paths may or may not employ physical wires.

FOUR-WIRE TERMINATING SET - a hybrid arrangement by which a four-wire circuit is terminated on a two-wire basis for connection with two-wire circuits.

IDLE CIRCUIT TERMINATION (ICT) - a function performed by a trunk or line equipment in its idle condition to prevent singing of a trunk or line equipped with gain devices. An ICT can take one of several forms (a physical termination, a gain disabler, an open, or a short), and should be automatically removed when the circuit is in use.

INTERDIGITAL TIMING - the minimum time required between digits for the switching equipment to respond to the last digit received and ready itself for receiving the next digit.

INTERFACE CONNECTING BLOCK - the Telephone Company furnished connecting point to which the customer brings and connects the leads of his equipment and to which the Telephone Company brings and connects leads from the voice connecting arrangement.

NETWORK CONTROL SIGNALING - denotes the transmission of signals used in the telecommunications system which perform functions such as supervision (control, status, and charging signals), address signaling (dialing), calling and called number identification, audible tone signals (call progress signals indicating reorder or busy conditions, alerting,

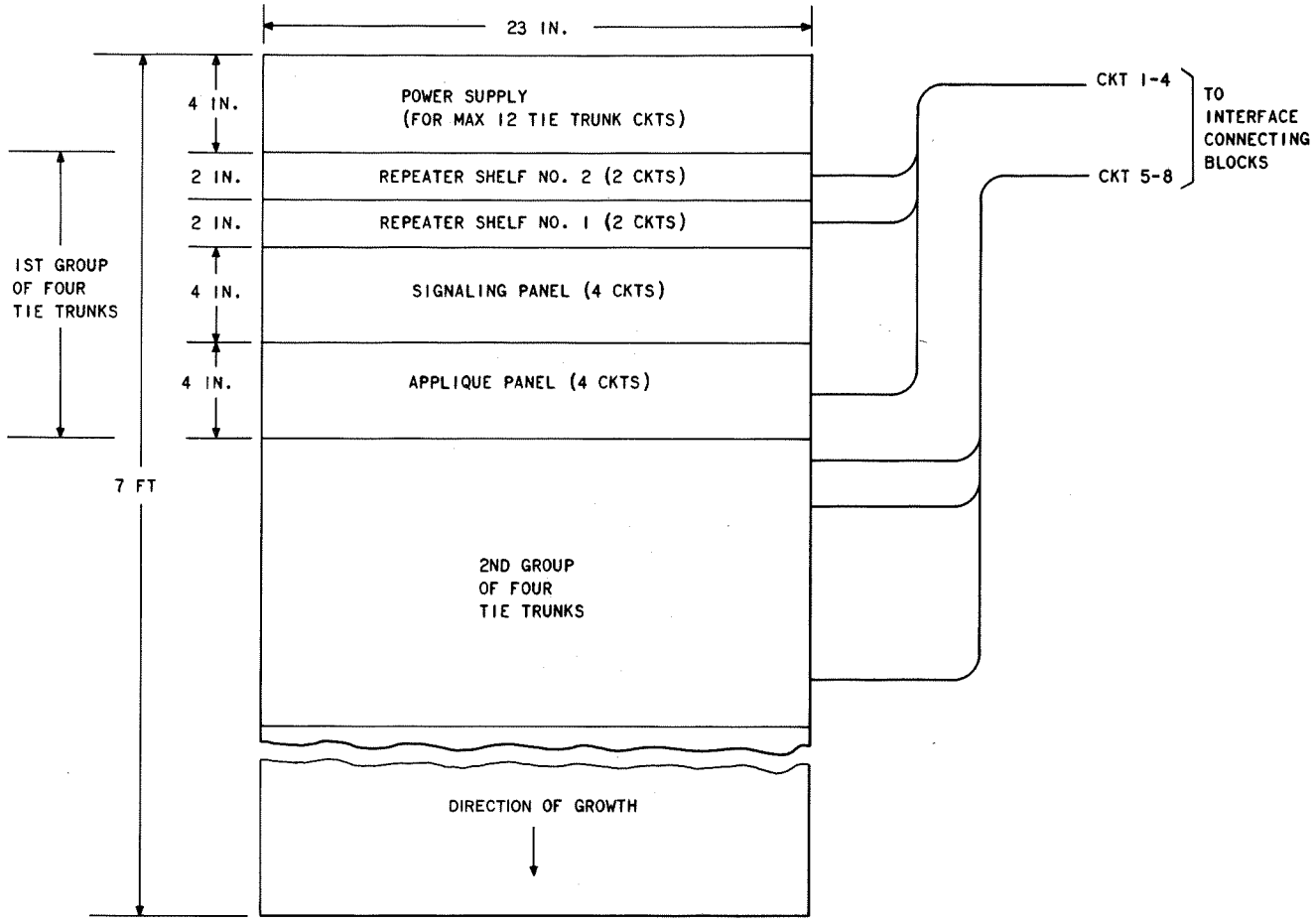
coin denomination, coin collect and coin return tones) to control the operation of switching machines in the telecommunications system.

PERCENT BREAK - the period of time of an open interval compared to the total time of an open and closed interval, expressed as a percentage.

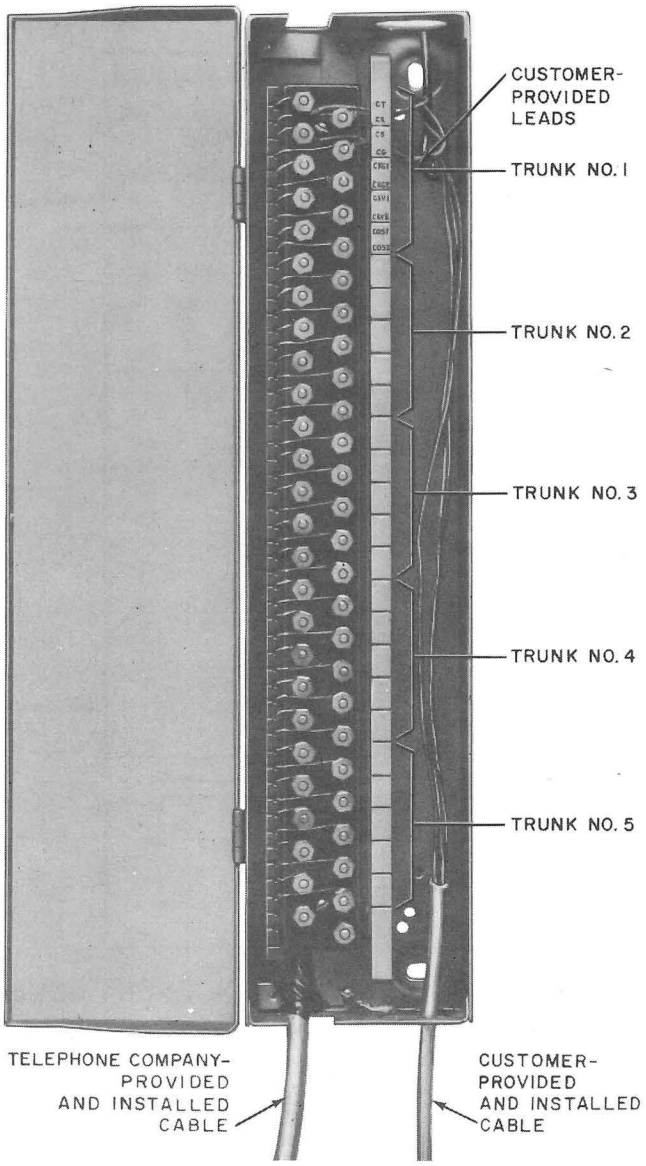
SUPERVISORY SIGNALS - the conditioning of the SUPERVISORY leads by the customer-provided equipment which indicates a customer's telephone is answering or originating a call, has disconnected from a call, or that the equipment is idle.

TELEPHONE COMPANY - denotes the American Telephone and Telegraph Company, the Long Lines Department, its concurring carriers and its connecting carriers, either individually or collectively.

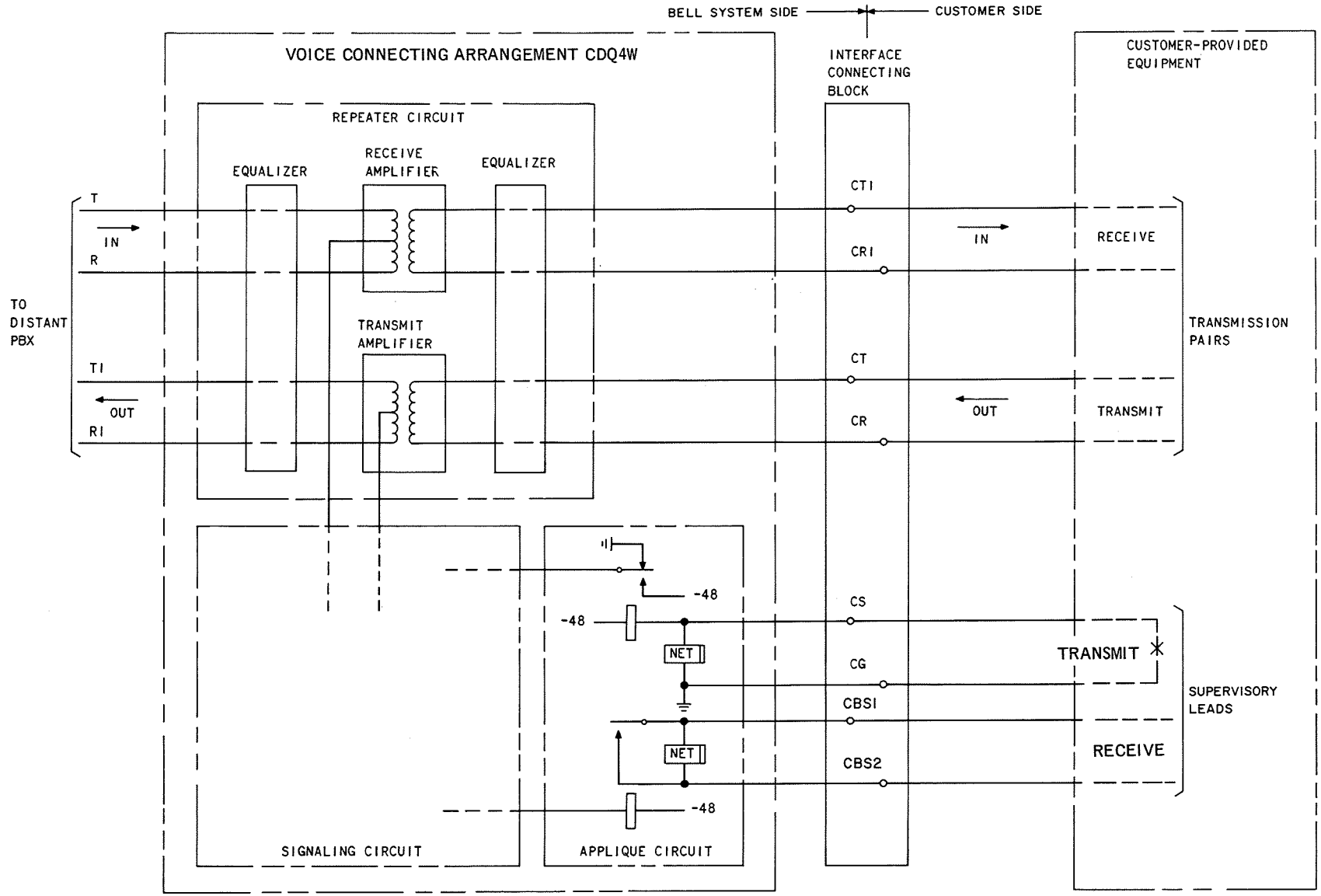
TRANSMISSION LEVEL POINT (TLP) - a point in a transmission system at which the transmission level (expressed in dB) is defined as the nominal or design gain (or loss) at 1000 Hz referenced to an arbitrary point in the system called the 0 transmission level point (0 TLP).



VOICE CONNECTING ARRANGEMENT CDQ4W
Typical Relay Rack Mounting, Front View
Fig. 1



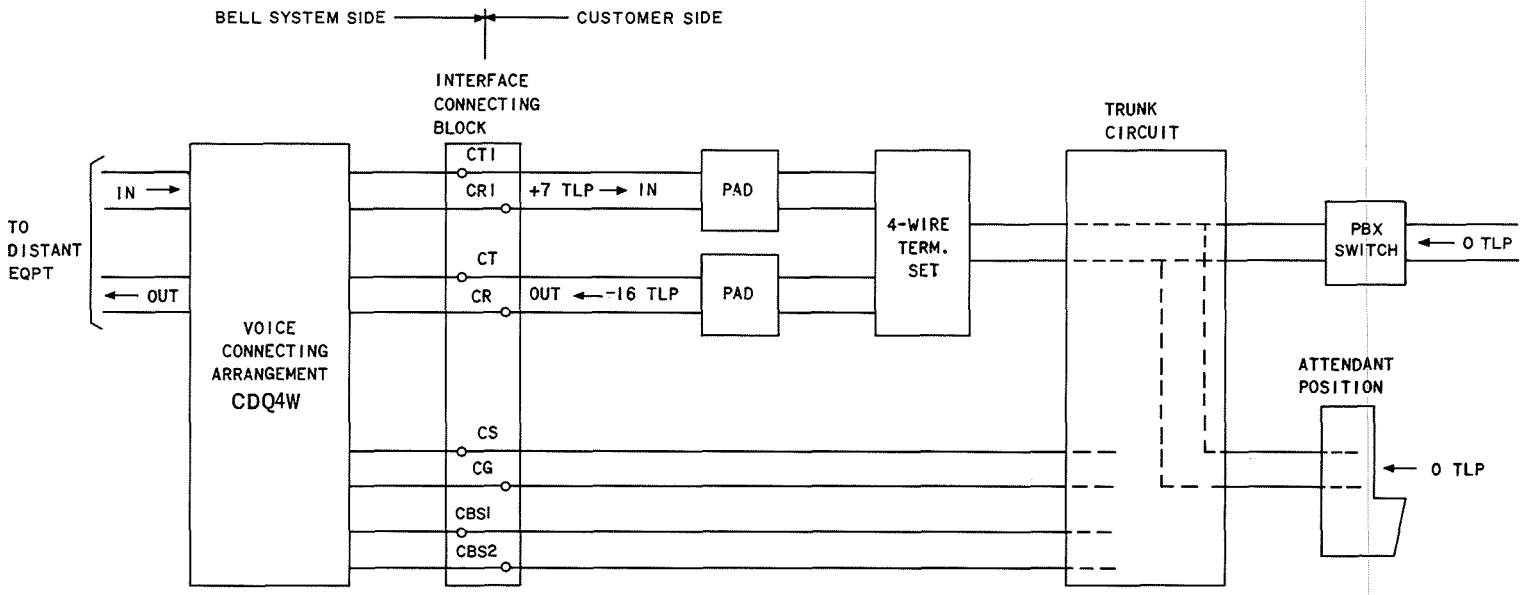
INTERFACE CONNECTING BLOCK
Fig. 2



SIMPLIFIED SCHEMATIC – VOICE CONNECTING ARRANGEMENT CDQ4W

Fig. 3

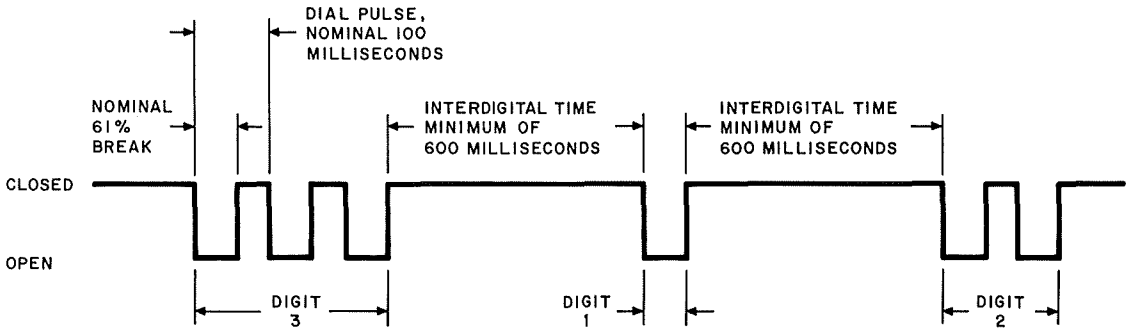
PRELIMINARY



BLOCK DIAGRAM – VOICE CONNECTING ARRANGEMENT CDQ4W

Fig. 4

TYPICAL PATTERN OF DIAL PULSES EXPECTED
FROM CUSTOMER-PROVIDED EQUIPMENT
OVER LEADS CS AND CG (DIALING NUMBER 312)



DIAL PULSE RATE-NOMINAL 10 PULSES PER SECOND (8 MIN-11 MAX.)
PERCENT BREAK-NOMINAL 61 (58 MIN-64 MAX.)
INTERDIGITAL TIME-MINIMUM OF 600 MILLISECONDS

DIAL PULSE CHARACTERISTICS
FIG. 5